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AUTOMATIC DATA PROCESSING OF RANGE VEGETATION INFORMATION

By

C. Eugene Conrad and Merton J. Reed
Range Conservationists

ABSTRACT: More than 2-1/4 man-months of laboratory and field time were saved by using automatic data processing in a large-scale continuing study of vegetation characteristics. A high-speed computer solved 57 separate problems in less than an hour, enabling researchers to determine sampling requirements for 19 species or species groups in three range sites.

Range researchers often face the formidable task of processing large quantities of data. Until a few years ago compilations, summaries, and analyses had to be done by hand. Now automatic data processing offers an alternative method. This paper reports the procedures followed in electronic machine processing of data from a study of vegetation characteristics.[1]

The large amount of data in a study recently begun at the San Joaquin Experimental Range in central California prompted us to try machine data processing in 1961. Analyses and programing had to be developed from scratch. Still, data from this study were processed in time to save us more than 2-1/4 man-months of laboratory and field time in 1962.

Automatic data processing had been used for several years at this Station for small studies in range and wildlife habitat research, but a large-scale continuing study of vegetation characteristics had never been set up for machine processing.

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[1] The authors wish to acknowledge the participation of the data processing group of this Station in making possible the successful completion of this work.

From 16 range units we selected some 1,800 random locations distributed among three principal range sites. At each of three plots per location, foliar composition, basal composition, and basal cover were estimated and the herbage clipped from a square-foot plot (fig. 1). We determined total yield and then handsorted 867 of the 1,800 herbage samples into 19 species or species groups. All data collected for each sample location were entered on a standard field form adapted to card-punching (fig. 2).

Card-punch operators transferred the 1961 data into punch cards after laboratory sorting was completed and each field form had been edited for completeness and accuracy. They punched two cards for the square-foot-plot field data and one card for the two supplemental plots at each sampling location. For each of the 867 sorted plot clippings, two additional cards were punched for sorted weights. Altogether more than 7,000 cards were punched. Data on foliar composition, basal composition, and basal cover were recorded and punched as alphabetic characters. Other data were collected and punched in number codes. Machine operators devoted about 3 weeks to transferring foliar composition and plant weight data to 5,000 cards. The following tabulation shows the number of cards used and machine-operator time required to transfer all the information from field forms to punched cards ready for use in a computer:

Operation	Number of cards	Machine-operator time (weeks)
Punch and verify	7,000	4
Summary-punch:		
Foliar composition and weights	55,000	3
Basal composition and basal cover	114,000	3
Total	176,000	10

The 1961 data were used to determine the sampling needs for 1962 so that species foliar composition could be converted to an estimate of species weight composition. To make this determination, it was necessary to calculate the relationship of foliar composition to weight composition for each of the 19 species and species groups. This relationship can be expressed as a ratio but in order to evaluate its accuracy, the variance of each procedure for estimating composition and its ratio must be determined. When calculations of the ratios and variances were completed for the 1961 data, the size of the sample needed to be within desirable limits of accuracy in 1962 could be determined. The variability for five major species and species groups would be given most consideration in estimating the size of the 1962 sample. But we wanted to know how accurately this sample would estimate the composition of the other species and species groups.

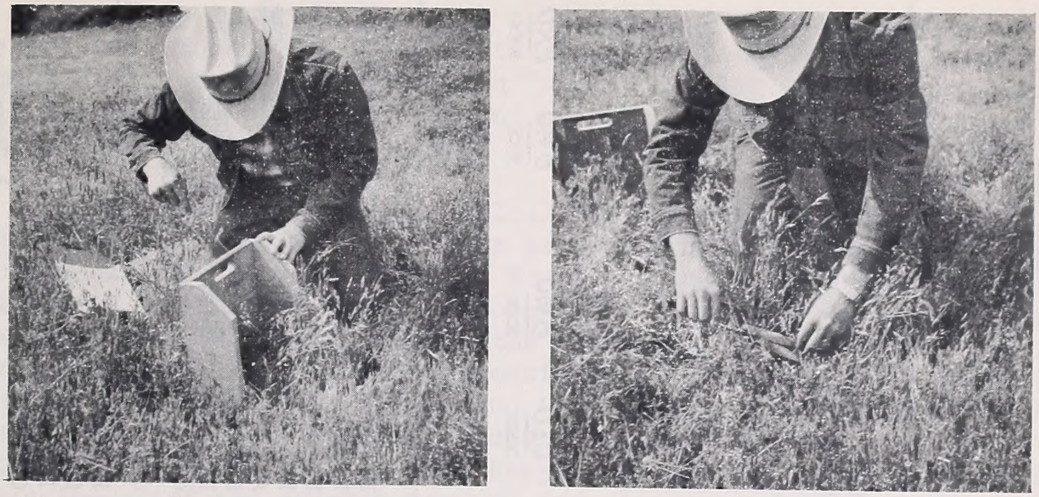

Figure 1.--A researcher estimates foliar composition of range vegetation by a point-frame technique, left, at the San Joaquin Experimental Range. He then clips the herbage, right.

A high-speed electronic computer made the calculations to determine the ratios and variances. Each input card contained information only for a single species at a location. Thus 19 input cards were made for each location. For one species or species group from a location an input card included the number of hits in the square-foot plot and in the supplemental plots, and the species' air-dry weight if the card represented a sorted plot. The total weight of all species and the total number of pins used on the square-foot plot and supplemental plots were also punched into each computer input card. To obtain these input cards, an average of eight intermediate cards were prepared from two punched-cards for a single unsorted plot and its supplemental plots. Some 16 intermediate cards were prepared from 4 punched-cards for a sorted plot and its supplemental plots. In addition to the regular input cards, control cards for each problem also had to be made to identify the species and species groups and to supply information about the number of plots, the range sites, and the number of species.

In less than an hour the computer solved 57 separate problems to determine ratios and variances for the relationship between foliar and weight composition. As a result of these computations, we reduced the number of handsorted plots by 32 percent in 1962. If conditions of sampling are the same in 1962 as in 1961, this reduction of information on foliar composition to be recorded will cut field sampling time by 3 man-days and laboratory sorting time will be decreased by 9 man-weeks. Finally, data processing time should be shortened by almost 2 man-days.

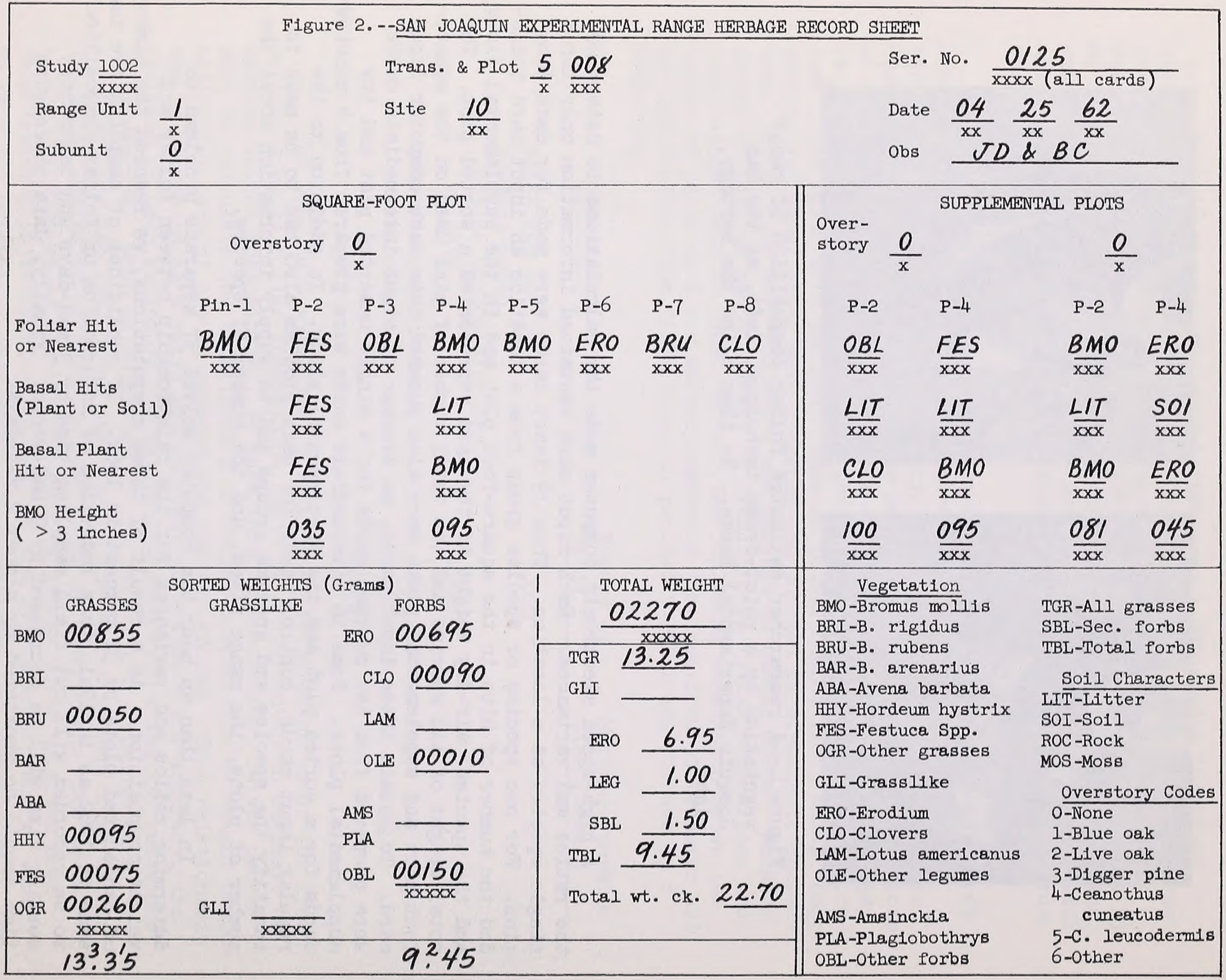

Figure 2.--SAN JOAQUIN EXPERIMENTAL RANGE HERBAGE RECORD SHEET

Study 1002 (xxxx)
Range Unit 1 (x)
Subunit 0 (x)

Trans. & Plot 5 (x) 008 (xxx)
Site 10 (xx)

Ser. No. 0125 (xxxx (all cards))
Date 04 (xx) 25 (xx) 62 (xx)
Obs JD & BC

SQUARE-FOOT PLOT

Overstory 0 (x)

	Pin-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8
Foliar Hit or Nearest	BMO xxx	FES xxx	OBL xxx	BMO xxx	BMO xxx	ERO xxx	BRU xxx	CLO xxx
Basal Hits (Plant or Soil)		FES xxx		LIT xxx				
Basal Plant Hit or Nearest		FES xxx		BMO xxx				
BMO Height (> 3 inches)		035 xxx		095 xxx				

SUPPLEMENTAL PLOTS

Over-story 0 (x)   0 (x)

P-2	P-4	P-2	P-4
OBL xxx	FES xxx	BMO xxx	ERO xxx
LIT xxx	LIT xxx	LIT xxx	SOI xxx
CLO xxx	BMO xxx	BMO xxx	ERO xxx
100 xxx	095 xxx	081 xxx	045 xxx

SORTED WEIGHTS (Grams)

GRASSES		GRASSLIKE		FORBS	
BMO	00855			ERO	00695
BRI				CLO	00090
BRU	00050			LAM	
BAR				OLE	00010
ABA				AMS	
HHY	00095			PLA	
FES	00075			OBL	00150 xxxxx
OGR	00260 xxxxx	GLI	xxxxx		
	$13^{3}.3'5$				$9^{2}.45$

TOTAL WEIGHT
02270 (xxxxx)

TGR	13.25
GLI	
ERO	6.95
LEG	1.00
SBL	1.50
TBL	9.45
Total wt. ck.	22.70

Vegetation
BMO-Bromus mollis
BRI-B. rigidus
BRU-B. rubens
BAR-B. arenarius
ABA-Avena barbata
HHY-Hordeum hystrix
FES-Festuca Spp.
OGR-Other grasses

GLI-Grasslike

ERO-Erodium
CLO-Clovers
LAM-Lotus americanus
OLE-Other legumes

AMS-Amsinckia
PLA-Plagiobothrys
OBL-Other forbs

TGR-All grasses
SBL-Sec. forbs
TBL-Total forbs

Soil Characters
LIT-Litter
SOI-Soil
ROC-Rock
MOS-Moss

Overstory Codes
0-None
1-Blue oak
2-Live oak
3-Digger pine
4-Ceanothus cuneatus
5-C. leucodermis
6-Other

Speeding up data processing by electronic machines enabled us to get adequate information in ample time to draw conclusions--as reliable as possible in one year--concerning future sampling requirements. Refinements in collecting, processing, and analyzing data should provide even more savings in future years.

High-speed computers can calculate the ratio and variance problems described in this report in an hour or less compared with a minimum of 4 or 5 weeks for hand processing. Routine summarizing and compiling for analysis is improved by using personnel who are specialists in handling data. Machine processing enables the researcher to devote the time which previously had to be used for processing data to developing a better understanding of a study and to improving the analysis and conclusions. At the same time, a researcher must appreciate the uses and needs of automatic data processing. We were able to keep constantly in touch with the data-processing staff and quickly arrange any necessary changes in the programs.